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(54) PROTEIN-BASED FOOD

(71) We, BATTELLE MEMORIAL INSTITUTE, a body corporate organised under the laws of the State of Ohio, one of the United States of America, having laboratories and offices at 7, route de Drize, Carouge, Canton of Geneva, Switzerland, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement: —

This invention relates to a protein-based food.

There are at present three main processes for producing foods resembling various types of meat. In the first of these processes, a mixture of gluten, flour, fat and other less important ingredients is coagulated by heating in a hermetically sealed container. Unfortunately, the product thus obtained bears no real similarity to meat.

In the second process, a solution of proteins is injected into a coagulating bath so as to form fibres, and the fibres thus obtained are stretched and washed in order to remove the constituents of the coagulating bath. These fibres are then bonded together by means of a suitable binder and, finally, are coloured and aromatised. The product thus obtained is preserved either as much in a refrigerated state or in a dry form. The disadvantage of this process is that it is extremely complicated and delicate to carry out with the result that the retail price of the artificial meat thus obtained is higher than that of natural meat.

The third process, known as the baking-extrusion process, comprises baking a mass of suitably aromatised soya flour in the presence of water so as to hydrate it. The paste thus obtained is then extruded by means of a screw extruder at a pressure of several tens of atmospheres and at a temperature of from 100 to 150°C. On leaving the extruder, the mass expands whilst at the same time developing a cellular structure. The product thus obtained is cut into pieces of the required shape and size and is then dried. The product obtained by this process has a sponge-like structure resembling that of a minced meat. This product is known commercially as textured vegetable protein but in practice can only be consumed in admixture with natural meat. The advantage of this process over the second of the three aforementioned processes is that it is extremely direct, but it has the disadvantage that it is necessary to use heavy, expensive extruders.

It has also been proposed, in French Patent Specification No. 1,088,303, to manufacture a protein-based food product which is similar in texture to meat or meat-based foods such as meat pate. This product is in the form of a coherent, heterogeneous mass consisting of at least two phases, namely, on the one hand, separate, heat-stable and non-stretched particles of a gel based on a hydrated, non-oriented protein substance and, on the other hand, at least one phase formed from ingredients which are not part of this gel. The process by which this product is produced has the disadvantage of being difficult to carry out because of the delicate operations required to obtain a heterogeneous end product.

According to the present invention, there is provided a process for preparing a protein-based food, which comprises forming a homogeneous mixture consisting of an aqueous suspension of at least one isolated vegetable protein and at least one glucide and/or lipid, the degree of acidity and the protein content of the mixture being adjusted in such a way as to obtain a homogeneous gelable mass containing from 15% to 30% by weight of protein, based on the total weight of the gelable mass, heating the gelable mass so as to form a homogeneous gel, and reducing the water content of the gel thus obtained to a value of from 5 to 45%, based on the total weight of the resulting product, to form the desired food.

The food prepared by this process comprises a homogeneous gel containing from 5 to 45% by weight of water, at least one vegetable protein and at least one glucide and/or lipid.

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This food is intended to be consumed as such without any need for cooking, rehydration or other preparation.

When adjusting the degree of acidity before gelling, it is possible to adjust the pH of the isolated protein or of the mixture as a whole. The value of this pH is preferably in the range of from 5.7 to 6.4.

It is preferred to use seeds of oleaginous or leguminous plants as the source of the vegetable protein. The following plants are examples of suitable plants: peanut, sunflower, rapeseed, soya, cotton, pea and lupin plants. Soya protein isolated at its isoelectric point, i.e. at a pH of 5.9, and converted into a fine dry powder by spray-drying is particularly suitable for use as the vegetable protein.

The dietetic properties of the food of the invention can be varied by incorporating at least one protein of animal origin into the mixture. Examples of suitable animal proteins are casein, meat meal, and fish meal. The maximum quantity in which the animal protein can be incorporated in the mixture is usually approximately 45% by weight, based on the total weight of dry material. Beyond this quantity, the mixture will not gel and the consistency of the food obtained is unsatisfactory.

Any edible animal or vegetable fat can be used as the lipid. Preferably the maximum amount of lipid used is 20% by weight, based on the total weight of the mixture before reduction of its water content. Examples of suitable glucides (e.g. carbohydrates) are monosaccharides such as, for example, glucose, saccharose and lactose; and di- and trisaccharides. Mixtures of glucides can be used. The maximum quantity of glucide used is preferably 15% by weight, based on the total weight of the mixture before reduction of its water content.

In order to provide the food with suitable organoleptic properties, various aroma-imparting agents, colorants, spices and mineral or organic salts can be incorporated into the mixture before gelling. Examples of suitable spices are pepper, cinnamon, and vanilla, and examples of suitable salts are sodium chloride and sodium glutamate. The quantities in which these ingredients are used will of course depend upon their type and upon the intensity of the organoleptic property which it is desired to obtain. Depending upon the choice of the aroma-imparting agents, spices, colorants and salts, it is possible to obtain foods differing widely in flavour, odour and colour. The texture of the food is usually similar to products obtained by the transformation of meat and to delicatessen products and therefore it is preferable to aromatise and colour the mixture accordingly. Thus, the food can have an appearance, consistency and organoleptic properties similar to those of delicatessen products, for example dried meat, Parma ham, dry sausage, pickled fish and fresh fish. However, it is possible to provide the food with a different flavour, for example with the flavour of cheese.

In order to provide the food with a certain degree of elasticity and also to increase its water-retention capacity, it is possible to incorporate into the mixture before it is gelled a quantity of gelatin corresponding to a content of from 1 to 4% by weight, based upon the weight of the mixture before reduction of its water content, or a quantity of an edible hydrophilic agent corresponding to a content of from 1.4 to 5% by weight, based upon the weight of the mixture before reduction of its water content. Examples of suitable edible hydrophilic agents are polyalcohols such as glycerin and D-sorbitol (sorbitol) optionally in the form of syrup of sorbitol.

In order to stabilise the gel, particularly when the mixture contains a large quantity of fat, and also to improve the water-retention capacity of the food and to facilitate incorporation of the various ingredients of the mixture in homogeneous form, various salts of food-grade tribasic or other polybasic acids can be incorporated in the mixture before it is gelled. For example, it is possible to use for this purpose the sodium salts of citric acid, pyrophosphoric acid, pyrophosphoric acid, metaphosphoric acid and polyphosphoric acid, especially disodium pyrophosphate, tetrasodium pyrophosphate and sodium pentapolyphosphate, these salts being used individually or in admixture with one another. It is also possible to use other substances capable of improving the homogeniety of the food, for example palm-based sucroglycerides, monoglycerides and soya lecithin.

In order to facilitate gelling when a protein which does not gel very easily under heating is used, it is possible to incorporate gelling agents specific to proteins, for example carrageenates, into the mixture intended to form the gelable mass.

The process of the invention can be carried out, for example, as follows. A paste is formed by thoroughly mixing the various ingredients of the food at or around ambient temperature, each of the ingredients preferably being introduced in the order in which a high degree of homogeniety is most easily obtained in the paste. Thus, the water and the ingredients readily soluble or dispersible in water are preferably mixed together first, after which the vegetable protein is dispersed with vigorous stirring in the solution or dispersion thus obtained and, finally, the glucide and/or lipid is incorporated into the mixture so as to form a homogeneous emulsion. If necessary, the mixture can be homogenised by subjecting it to a suitable treatment in a piston-type homogeniser.

The heat treatment to form a gel from the gelable mass comprises heating to a tempera-

ture whose level is governed above all by the type of vegetable protein and its proportion in the mixture and, to a lesser extent, by the nature of the other ingredients. This temperature is preferably in the range of from 60 to 160°C. Any suitable method of heating can be used for heating the gelable mass, for example heating in an oven or by means of a hot fluid such as hot water or steam, or microwave heating, especially by means of waves with a frequency of from 915 to 2450 Mc/s. Heating of the gelable mass can be carried out intermittently, in which case the mass is either kept at atmospheric pressure or is heated in a hermetically sealed container, for example in a crimped rim metal can or in an autoclave. The mass can also be gelled continuously, for example by spreading it over a heated surface such as a metal belt or a rotating cylinder, or by passing it through a continuous heat exchanger equipped with a thin-layer scraper so as to obtain the gel in a form particularly suitable for drying.

It is also possible, in order to obtain a homogeneous gel, to heat the gelable mass whilst subjecting it to agitation so as to ensure homogeneous distribution of heat, then to bring the mass into a compact form by stopping the agitator and transferring the mass into a suitably shaped mould under a light pressure, for example about 1 kg/cm², and finally to leave the mass to cool in this mould.

In order to reduce the water content of the gel, the gel can be progressively dried, for example by exposing it over a period of from 5 to 48 hours to air having a temperature of from 10 to 50°C and a relative humidity of from 70 to 80%. This drying can be carried out in a smoking chamber of the kind normally used for curing foods.

The gel can also be dried more quickly, but still progressively, by internal microwave heating more particularly by means of waves with a frequency of from 915 to 2450 Mc/s By using this method of heating, it is possible to increase the internal tensions in the product and to form friable zones therein, thereby to obtain a food with the appearance and the organoleptic properties of ham or fried bacon, but without their high fat content. In order to facilitate drying, the gel can be cut into thin slices, for example with a thickness of from 0.5 to 2 mm and a surface area of at least 10 cm², before it is dried. However, it is also possible to dry the gel in the form of large blocks and to cut the product into pieces of the required shape and size, preferably within the limits specified above, after drying. As already mentioned, the semi-dry product thus obtained is the form in which this food is normally consumed. In contrast, a protein-based food produced by the process described in French Patent Specification No. 1,088,303 is not normally consumed in dehydrated form.

The food of the invention is a polyvalent dietetic food by virtue of the fact that its composition can be varied within wide limits. Its content of proteins of high biological value can be relatively high whilst its fat content and the nature if the fats present can be determined as required within wide limits.

The invention will now be illustrated by the following Examples.

EXAMPLE 1

A plastic paste was prepared from the following ingredients, the quantities of which are expressed in % by weight:

Water	60.50
Dried whey	3.56
Gelatin	1.07
Sodium chloride	3.5
Sodium glutamate	1.78
Powdered soya protein (isolated by extraction at the isoelectric point at a pH of 5.9 after isolation and spray drying to form a fine dry powder)	17.80
Edible fat (hydrogenated peanut oil with a melting point of 40°C)	7.10
"Fondagil" (registered Trade Mark of Progil Company for a mixture disodium pyrophosphate, tetrasodium pyrophosphate and sodium pentapolyphosphate)	0.97
Edible flavouring	1.64
Colorant	0.25
Pepper	0.35

The paste was prepared as follows. The powdered whey, gelatin, sodium chloride, sodium glutamate, glycerin, "Fondagil", and colorant, were dissolved in water at ambient temperature. The soya protein was then incorporated in the aqueous solution thus obtained with vigorous stirring in order quickly to disperse the protein powder. The edible fat was then incorporated into the suspension thus obtained in the form of a melt containing the edible flavouring, stirring of the mixture being continued so as to form an emulsion. This emulsion was then homogenised in a piston-type homogeniser to form a semi-fluid paste. The paste was introduced into cylindrical metal cans with a diameter of 75 mm and a height of 60 mm, which were hermetically sealed by crimping after they had been completely filled with the paste. The cams were then heated to 110°C over a period of 20 minutes, after which they were opened and the mixture, which now had the consistency of gelled blocks, removed from them. These blocks were cut into 1 mm thick slices which were dried by exposure for 5 hours to a stream of hot air with a temperature of 40°C. Drying was stopped when the water content of the product was between 15 and 20% by weight. The food thus obtained was stable at ambient

temperature and could be stored for several weeks without alteration in the absence of any particular precautions.

EXAMPLE 2

A mixture with the following composition, in which quantities are expressed in parts by weight was prepared in the same way as described in Example 1:

Water	850.0
Powdered soya protein isolated at its isoelectric point	250.0
Dried whey	50.0
Gelatin	15.0
Sodium chloride	25.0
Cocoa fat	100.0
Glycerin	20.0
Sodium sorbate	1.4
"Fondagil 6"	5.8
"Fondagil 10"	5.8
"Fondagil 12"	2.18
Colorants	0.4
Caramel	2.0
Edible flavouring	16.0
Monosodium phosphate (NaH_2PO_4)	4.0

"Fondagil 6", "Fondagil 10" and "Fondagil 12" are mixtures of disodium pyrophosphate, tetrasodium pyrophosphate and sodium pentapolyphosphate.

This mixture was homogenised as described in Example 1. A gelable mass was thus obtained in the form of a perfectly homogeneous, semi-fluid paste with a water content of 63% by weight.

A 2 kg batch of this paste was introduced into a mould and heated for 90 minutes to 85°C by immersing the mould in a bath of hot water. The gel block thus obtained was then removed from the mould and dried for 48 hours in air of 70% relative humidity at a temperature of 11°C. Thereafter, the block was kept in a smoking chamber for 48 hours at 20°C and, finally, for 48 hours at 11°C in a drying cabinet filled with air of 78% relative humidity.

The food thus obtained was in the form of a homogeneous block with extremely good elasticity and a water content of 23.2%, very similar to a piece of partially dried beef of the "viande des grisons" type. The block was cut into thin transparent slices in exactly the same way as a block of natural "viande des grisons".

EXAMPLE 3

The procedure of Example 2 was repeated, except that the gelable mass was heated for 3 minutes in a microwave oven at a frequency of 2450 Mc/s, and then for 45 minutes in a water bath heated to 85°C.

EXAMPLE 4

The procedure of Example 3 was repeated, except that, instead of being introduced into a mould, the gelable mass was introduced into sausage casings, after which the product was kept in a smoking chamber for 48 hours at 20°C, and then for 7 days at 11°C in a drying cabinet filled with air of 78% relative humidity.

A food very similar to beef sausage was obtained.

EXAMPLE 5

The procedure of Example 2 was repeated, except that, after the homogeneous gelable mass had been obtained, it was subjected to a heat treatment, in batches of approximately 2 kg in a mixer heated by steam under a relative pressure of 1.6 atmospheres.

The mass, still in a semi-fluid state, was introduced into moulds under a pressure of about 1 kg/cm² without being allowed to cool.

The mass was then allowed to gel by cooling in the moulds, after which the gel was removed from the mould and subjected to the smoking and drying treatment described in Example 4 to obtain a food.

EXAMPLE 6

The procedure of Example 2 was repeated, except that the homogeneous gelable mass obtained was passed downwards between two rotating hollow steel cylinders with parallel axes which were 16 cm in diameter and 15 cm wide, with a 1 mm wide gap between them. The cylinders were heated internally with steam at a relative input pressure of 2 atmospheres, and rotated in opposite directions at a speed of 1 revolution every 45 seconds.

The gel obtained in this way was in the form of an approximately 1 mm thick strip with a water content of from about 35 to 45%. This strip was subjected to the smoking and drying treatment described in Example 2 to obtain a food.

EXAMPLES 7 to 9

The procedure of Example 2 was repeated, with the following variations in the composition of the mixture:

Example 7: the monosodium phoshate was omitted;

Example 8: sodium chloride was used in a quantity of 50 parts instead of 25 parts;

Example 9: the monosodium phosphate was replaced by 4 parts of monocalcium phosphate ($CaHPO_4$).

The foods obtained were similar to the food obtained in Example 2.

WHAT WE CLAIM IS:—

1. A process for preparing a protein-based food, which comprises forming a homogeneous mixture consisting of an aqueous suspension of at least one isolated vegetable protein and at least one glucide and/or lipid, the degree of acidity and the protein content

of the mixture being adjusted in such a way as to obtain a homogeneous gelable mass containing from 15% to 30% by weight of protein, based on the total weight of the gelable mass, heating the gelable mass so as to form a homogeneous gel, and reducing the water content of the gel thus obtained to a value of from 5 to 45%, based on the total weight of the resulting product, to form the desired food.

2. A process according to claim 1, in which the vegetable protein is obtained from an oleaginous or leguminous plant.

3. A process according ot claim 2, in which the plant is one of the following: peanut, sunflower, rapeseed, soya, cotton, pea and lupin.

4. A process according to claim 3, in which the vegetable protein is soya protein isolated at its isoelectric point.

5. A process according to any one of the preceding claims, in which at least one animal protein is incorporated into the mixture.

6. A process according to claim 5, in which the animal protein is casein, meat meal or fish meal.

7. A process according to claim 5 or 6, in which the quantity of animal protein incorporated into the mixture is not more than 45% by weight, based upon the total weight of dry material in the mixture.

8. A process according to any one of the preceding claims, in which the amount of lipid(s) incorporated into the mixture is not more than 20% by weight, based upon the total weight of dry material in the mixture.

9. A process according to any one of the preceding claims, in which the amount of glucide(s) incorporated into the mixture is not more than 15% by weight, based upon the total weight of dry material in the mixture.

10. A process according to any one of the preceding claims, in which gelatin is incorporated into the mixture, before the mixture is gelled, in an amount of from 1 to 4% by weight, based on the weight of the mixture before reduction of its water content.

11. A process according to any one of the preceding claims, in which an edible hydrophilic agent is incorporated into the mixture, before the mixture is gelled, in an amount of from 1.4 to 5% by weight, based on the weight of the mixture before reduction of its water content.

12. A process according to any one of the preceding claims, in which a salt of a food-grade polybasic acid or another substance capable of improving the homogenity of the food is incorporated into the mixture before the mixture is gelled.

13. A process according to any one of the preceding claims, in which a gelling agent is incorporated into the mixture before the mixture is gelled.

14. A process aoccrding to any one of the preceding claims, in which an aroma-imparting agent, a colorant, a spice, a mineral salt or an organic salt is incorporated into the mixture before the mixture is gelled.

15. A process according to any one of the preceding claims, in which the gelable mass is heated in an oven.

16. A process according to any one of claims 1 to 14, in which the gelable mass is heated by means of a fluid.

17. A process according to claim 16, in which the fluid is water in its liquid form.

18. A process according to claim 16, in which the fluid is steam.

19. A process according to any one of claims 1 to 14, in which the gelable mass is heated by microwaves.

20. A process according to claim 19, in which the microwaves have a frequency of from 915 to 2450 Mc/s.

21. A process according to any one of the preceding claims, in which the gelable mass is heated in batches in a sealed container.

22. A process according to claim 21, in which the sealed container is an autoclave.

23. A process according to claim 21, in which the sealed container is a crimped metal can.

24. A process according to any one of claims 1 to 20, in which gelling of the mass is carried out continuously by passing the gelable mass over a heated surface.

25. A process according to claim 24, in which the heated surface is the surface of a rotating cylinder.

26. A process according to any one of claims 1 to 20, in which gelling of the mass is carried out continuously by passing the mass through a continuous heat exchanger provided with a thin-layer scraping means.

27. A process according to any one of claims 1 to 20, in which gelling of the mass is carried out by heating the gelable mass while stirring so as to ensure homogeneous distribution of heat, and bringing the mass into a compact form by transferring the mass into a mould under pressure and allowing the mass to cool.

28. A process according to any one of the preceding claims, in which the gelable mass is heated at a temperature of from 60° to 160°C.

29. A process according to any one of the preceding claims, in which the gelable mass is heated under atmospheric pressure.

30. A process according to any one of the preceding claims, in which the homogeneous gel or the desired food is cut into slices with a thickness of from 0.5 mm to 2 mm before or after reduction of the water content.

31. A process according to any one of the preceding claims, in which the water content of the gel is reduced by exposing it to air

having a temperature of from 10°C to 50°C and a relative humidity of from 70 to 80%.

32. A process according to any one of claims 1 to 30, in which the water content of the gel is reduced by internal microwave heating at a frequency of from 915 Mc/s to 2450 Mc/s.

33. A process for preparing a protein-based food, substantially as described in any one of the foregoing Examples.

34. A protein-based food whenever prepared by the process claimed in any one of the preceding claims.

35. A protein-based food, substantially as described in any one of the foregoing Examples.

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